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(54) A HAND TOOL FOR EXPANDING PIPE ENDS

(71) We, ROTHENBERGER GMBH & CO., WERKZEUGE-MASCHINEN KG., a Germany Company, of 6000 Frankfurt/Main, Heidelbergerstrasse, 13 Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a hand tool for expanding the ends of pipes, the tool being of the type comprising a body containing an axially movable tapering mandrel displaceable by the application of an external force, and an expander head which is exchangeably attachable to said body coaxially with the mandrel, and which contains an assembly of expanding members projecting from the expander head and presenting external surfaces in the form of sector surfaces of a cylinder, said expanding member being radially separable by the thrust of the advancing mandrel by reason of their inner edges facing the mandrel forming a recess conforming with the mandrel taper, and each expanding member being divided into an anner sector radially supporting an outer sector.

Hand tools of this particular kind may be used to expand the end of a pipe to create a socket for the reception of the spigot end of a like pipe. So-called slip-on sleeves, i.e. lengths of tubing for insertion between two already firmly installed pipes are similarly prepared. Such a hand tool has particular application for use by heating engineers and plumbers in the course of installational work.

One form of hand tool is described in the specification of UK Patent No. 1,193,402. In this tool the mandrel which is longitudinally movably mounted in the body of the tool is displaceable by an eccentric acting on the mandrel end remote from its conically tapering end. The eccentric is fast with an arm provided with a handle. A second arm carrying a handle is firmly attached to the body of the tool which thus resembles a kind of tongs from one side of which the tapering end of the mandrel projects through an opening surrounded by a screw thread.

An exchangeable expander head containing expanding members of the above-described kind can be attached to the body of the tool by screwing it on the said threads. When the two lever arms are closed by pressing their handles together the mandrel is driven into the central recess between the expanding members and causes them to be forced radially apart. The end of a pipe embracing the expanding members will therefore be correspondingly enlarged to the extent required for the spigot end of a like pipe to be received into the socket thus formed. It will be understood that depending on the nature of the material of which the pipe is made and the thickness of its wall, considerable forces must be generated to effect the required enlargement and that the necessary effort can only be reduced to acceptable proportions by making the lever arm long enough to provide the required mechanical advantage.

Exchangeability of the expander head is necessary to enable expander heads having expanding elements of different outside diameters to be attached to the same tool body. According to the number of different pipes with which he may have to deal a plumber may therefore be obliged to carry an entire set of different expander heads in his tool kit. The range of expander heads which the makers of such a tool must produce is usually much greater than that required by any one workman and may range from outside diameters of 10 mm to diameters of 100 mm and even more. This also makes stock-keeping and expensive matter.

A set of undivided expanding members for such a hand tool may generally be produced from a solid cylindrical blank which is first provided with a central recess of corresponding shape to that of the mandrel taper. A peripheral radially

projecting flange is provided to serve as a stop face on the expander. This cylindrical blank containing a central recess and a circumferential flange or rim may then be divided into six sectors of equal size, for instance with a saw blade creating a cut of not inconsiderable width so that the material removed by the cut will leave a gap sufficient for the sectors to be pushed radially together. In this contracted position which may be described as the minimum diameter position the expanding sectors can be inserted into the end of an unexpanded pipe and then expanded with the simultaneous enlargement of the pipe end until the sectors have reached the positions which correspond to those they occupied in the original solid cylinder from which they have been cut. However, suitable expanding members could also be produced as precision castings complying with the above-defined geometrical relationships.

The expander head may have the form of an axially symmetrical screw cap containing an axial bore of smaller diameter than the internal diameter of the screw cap. The expanding members are then so inserted into the expander head that the edge of the flange or projecting rim bears against the flat surface surrounding the axial bore, whereas the expanding surfaces of the expanding sectors project through the bore to the outside. The bore in such an arrangement must always be greater than the envelope surface of the sectors when fully expanded (maximum diameter position). The external diameter of the expander head itself must be still larger by a considerable amount. The production of such an expander head involves a large amount of machining which substantially affects the cost price of such a hand tool.

Another major drawback is the great weight of such expander heads and their expanding members. It has already been mentioned above that a plumber would normally have to carry several such expander heads in his kit. It must also be remembered that for larger pipe diameters the weight rises at a very rapid rate and in such cases the length of the lever arms for the handles must also be chosen to provide the required mechanical advantage. Although desirable leverages for generating the necessary force for expansion can thus be provided, the heavy expander head of the tongs-like tool is at the end remote from the manipulating handles and for expanding members that are suitable for major pipe diameters such expander heads are then very difficult to insert into a pipe end with one hand. These difficulties become even greater when the tool is fitted with stepped multiple diameter expanding members suitable for several different sizes of pipe, since the overall diameter of the expander head must always exceed the external diameter of the largest expanded diameter.

Attempts have already been made to eliminate the need for keeping a large range of expander heads in stock and nevertheless to widen the universality of the applicational range of the tool by dividing the expanding members, as hereinabove already mentioned. In such an arrangement the outer sectors are loosely held together by a spring ring in the form of an annulus of sectors which can be slidably mounted on a set of inner sectors. By providing a range of sets of outer sectors of different thickness the tool can be used for expanding the ends of pipes of different diameters. Axial location of the outer sectors on the inner sectors is provided by an annular slot and key permitting the outer sectors to move freely on the inner sectors in the circumferential direction. However, this results in misalignment of the radial divisions separating the inner and the outer sectors and apart from the effort needed to deform the pipe the considerable frictional resistance between the inner and outer sectors must also be overcome. Moreover, the outer sectors tend to collect on one side and therby to open excessively wide gaps on the other side, a circumstance which causes inadmissible deviations from the circular of the exanded circumference of the pipe. This form of construction has therefore since been abandoned.

It is an object of the present invention to improve a hand tool of the initially herein-specified type.

According to the invention there is provided a hand tool for expanding the ends of pipes, comprising a body containing an axially movable tapering mandrel displaceable by the application of an external force, and an expander head which is exchangeably attachable to said body coaxially with the mandrel, and which contains an assembly of expanding members projecting from the expander head and presenting external surfaces in the form of sector surfaces of a cylinder, said expanding members being radially separable by the thrust of the advancing mandrel by reason of their inner edges facing the mandrel forming a recess conforming with the mandrel taper, and each expanding member being divided into an inner sector radially supporting an outer sector, wherein each outer sector is congruently associated with a corresponding inner sector to which it is securely but exchangeably attached.

The method of securing the outer sectors to the inner sectors by radial screws can be advantageously utilised to generate inwardly projecting bosses or pips inside the expanded socket end of the pipe. These

assist in centring the spigot end of another pipe and also give rise to the creation of a capillary clearance gap which assists the introduction of solder. This is achieved by countersinking the surface of the screw heads in the outer sectors sufficiently to create a shallow recess. This need not amount to more than a few tenths of a millimetre in depth so that the pips formed during expansion of the pipe end will be very flat.

It is also desirable for the outer sectors adjacent the expander head to be provided with a circumferential flange or rim having an external diameter which in fully contracted position still exceeds the inner diameter of the pipe that is to be expanded. This flange prevents the pipe end from being pushed beyond the end of the expanding surfaces. If this were the case an incurved edge at the end of the expanded pipe would be formed preventing the pipe from being easily pulled off the expander, if at all.

The external force is preferably applied to the mandrel by a screw spindle turned by a ratchet gear since this permits the major forces needed for the larger diameter expanding members to be more easily transmitted. Moreover, the consequent impossibility of an accidental withdrawal of the mandrel is also a major advantage.

It is further convenient to design the mandrel in the form of a truncated pyramid (having a triangular to octagonal or more angled cross-section) because this ensures an absolutely flush surface-to-surface contact in every position of the mandrel, besides preventing the inner sectors from tilting and thus suffering more wear.

An embodiment of the invention, the manner in which it functions and particulars of its construction will now be described in detail and reference made to Figures 1 to 3 of the drawings in which:—

Figure 1 is an axial section of a hand tool and of an expander head containing expanding members adapted to be screwed to the body of the tool, in accordance with the invention;

Figure 2 is a section on a larger scale than Figure 1 of the expander head showing two types of outer sector and their means of attachment; and

Figure 3 is a section taken on the line III—III in Figure 2.

Referring to Figure 1 a body 10 of substantially axially symmetrical construction is provided at its bottom end with screw threads 11. The body 10 carries a radially projecting arm 12 which is fitted with a handle at its extreme end, not shown in the drawing. An axial bore through the body 10 contains screw threads 13 for a working spindle 14. The end of the spindle 14 is fitted with a tapering mandrel 15 which projects from the body 10. The shape of the tapering mandrel 15 is that of a slim hexagonal pyramid with a tang 16 which only loosely fits into an axial blind bore 17 in the end of the spindle 14. Thrust is transmitted through a spherical butt face 18 which provides all the required degrees of freedom for the spindle 14 and the mandrel 15 to move independently. The mandrel 15 is secured and retained by a split ring 18 fitted in a manner affording adequate all-round clearance.

The other end of the spindle 14 has a square end 19 to which a lever arm 21 and ratchet mechanism 20 can be applied. The free end of this arm likewise carries a handle.

The arm 21 can be worked to and fro in a plane normal to the plane of the drawing. According to the adjustment of the ratchet gear 20 this causes the spindle 14 and the mandrel 15 to be retracted or advanced. Two threaded rings 14*a* and 14*b* which can be locked in position by skew contact form an adjustable stop.

An expander head which is attachable to the part of the tool so far described is generally indicated by 22. It comprises a cup-shaped sleeve 23 containing internal threads 24 matching the external threads 11. The sleeve 23 is provided near its bottom end with a recessed interval groove 25. The bottom contains a hole 26 for the reception of six expanding members 27 of which only three can be seen in the drawing. Each expanding member is divided and comprises an inner sector 28 and an outer sector 29 separated by a cylindrical interface 30. The outer sectors are detachably secured in a manner shown in detail in Figure 2. It will be seen that the external diameter of the outer sectors 29 exceeds the diameter of the opening 26 in the bottom of the sleeve 23.

The outer sectors have a cylindrical external surface 31 which may be described as the expanding surface. In the position shown in the drawing, the several cylinder surfaces of the expanding sectors do not make up a complete cylinder surface. The ends of the inner sectors 28 extending into the interior of the sleeve 23 have a retaining flange 32 containing a peripheral groove for the reception of a gapped spring ring 33. The ring operates to keep the expanding sectors in the illustrated position.

The inside ends of the inner sectors 28 are cut away in a manner generating a recess conforming to the shape of the mandrel 15, i.e., in the illustrated example a recess in the form of a hollow hexagonal pyramid. When the mandrel 15 is advanced into this recess 34 the expanding members 27 are forced radially outwards and they consequently conformably expand the end of a pipe, not

shown, into which the expanding members have been inserted.

The ends facing the sleeve 23 of the outer sectors 29 form a peripheral flange 35. The overally diameter of this flange in the illustrated fully retracted position of the expander exceeds the internal diameter of the pipe end that is to be enlarged.

In Figure 2 parts corresponding to like parts shown in Figure 1 are identified by the same reference numbers. On the left hand side the drawing shows an outer sector 29 which has an expanding surface 31 which is completely cylindrical with the exception of the terminal flange 35. The sector is secured to an inner sector by meand of two hexagonal socket-head screws 37 which extend radially through the outer sector 28 to the inside. The outer surfaces of the screw heads which bear no special reference number are countersunk below the outer surface of the expanding members. Consequently, a pipe end 38 into which the expander has been inserted will here slightly deform by forming an internal pip 39 as the expanding operation proceeds.

The right hand half of Figure 2 shows an outer sector 29' which is formed with two expanding surfaces 31' of different diameters. It will be seen that the expanding surface 31' of major diameter axially embraces part of the sleeve 23. This affords the further advantage that the transmission of force from the mandrel 15 to the expanding surface 31' is substantially entirely in the radial direction so that the slim inner sectors 28 (of identical dimensions) are in practice hardly subjected to bending loads. In the conventional type of expander such an arrangement would have been impossible.

Figure 3 shows the expanding members 27 in their fully expanded position in which their several cylindrical surfaces, i.e., expanding surfaces 31, together exactly define a cylinder surface. This surface is that of the original cylindrical blank from which the outer sectors have been cut, a saw blade removing the material to create gaps of width "*s*" which provide sufficient space for the expanding members to be pushed together and thus to contract.

It will be understood by reference to Figures 2 and 3 that the inner sectors 27 can be fitted with outer sectors of different shapes and sizes for which purpose it is merely necessary to select screws 37 of appropriate lengths. The position of the screws is not shown in Figure 3. However, the axes of the screws should coincide with the bisectors of the sectors 28 and 29.

The arrangement described with reference to the drawings affords several advantages. First and foremost the design of the inner sectors can be based exclusively on the mechanical properties required to withstand the bending moments and the frictcional wear by the mandrel, and they can be made of a high grade steel. This permits the inner sectors to be of very small overall diameter and the dimensions of the expander head to be commensurably reduced. Assembly units comprising expander head and inside sectors may in this form be kept in stock in large numbers. It is nevertheless possible to associate the inner sectors with suitably adapted outer sectors having a large variety of outside diameters which may equal that of the expander head and even exceed it. In the latter case the outer sectors may even partly embrace the expander head. In other words, only outer sectors of different sizes need by kept in stock in major numbers, and they may be manufactured from a lower quality material. Moreover, a replacement of the outer sectors by the plumber wherever he happens to be working is also possible and the total weight of the tool components he need carry in his kit is substantially reduced. An important advantage is the impossibility of the outer sectors shifting on the inner sectors either in the axial or in the peripheral direction, so that the divisions between the inner sectors will never be covered by the outer sectors (higher operating effort) and the outer sectors will not all slide to one side of the circumference (non-circular pipe ends).

Owing to the congruence between the sectors the centre angle of inner and outer sectors is the same and conveniently both can be produced in the same way, as above described, namely by radially dividing a blank in the form of a solid body of revolution.

WHAT WE CLAIM IS:—

1. A hand tool for expanding the ends of pipes, comprising a body containing an axially movable tapering mandrel displaceable by the application of an external force, and an expander head which is exchangeably attachable to said body coaxially with the mandrel, and which contains an assembly of expanding members projecting from the expander head and presenting external surfaces in the form of sector surfaces of a cylinder, said expanding members being radially separable by the thrust of the advancing mandrel by reason of their inner edges facing the mandrel forming a recess conforming with the mandrel taper, and each expanding member being divided into an inner sector radially supporting an outer sector, wherein each outer sector is congruently associated with a corresponding inner sector to which it is securely but exchangeably attached.

2. A hand tool according to Claim 1,

wherein the outer sectors are attached to the inner sectors by radial screws, and the screw heads are countersunk in the peripheral surface of the outer sectors.

3. A hand tool according to Claim 1 or Claim 2 wherein the outer sectors at least partly embrace the expander head.

4. A hand tool according to any of the preceding claims wherein the outer sectors form several different expanding surfaces having radii which increase in discontinuous steps.

5. A hand tool according to any of the preceding claims wherein the ends of the outer sectors adjacent the expander head are formed with a peripheral radially projecting flange having an overall diameter which, when the expander is fully contracted, exceeds the internal diameter of the pipe that is to be expanded.

6. A hand tool according to any of the preceding claims wherein the mandrel is connected to a driving spindle which is coaxially mounted inside the body of the tool, and that the spindle is turnable by a lever arm and ratchet mechanism.

7. A hand tool according to any of the preceding claims wherein the mandrel has the form of a truncated pyramid and that the recess formed centrally between the inner sectors is a complementary hollow pyramid.

8. A hand tool substantially as hereinbefore described with reference to the accompanying drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

FIG. 1

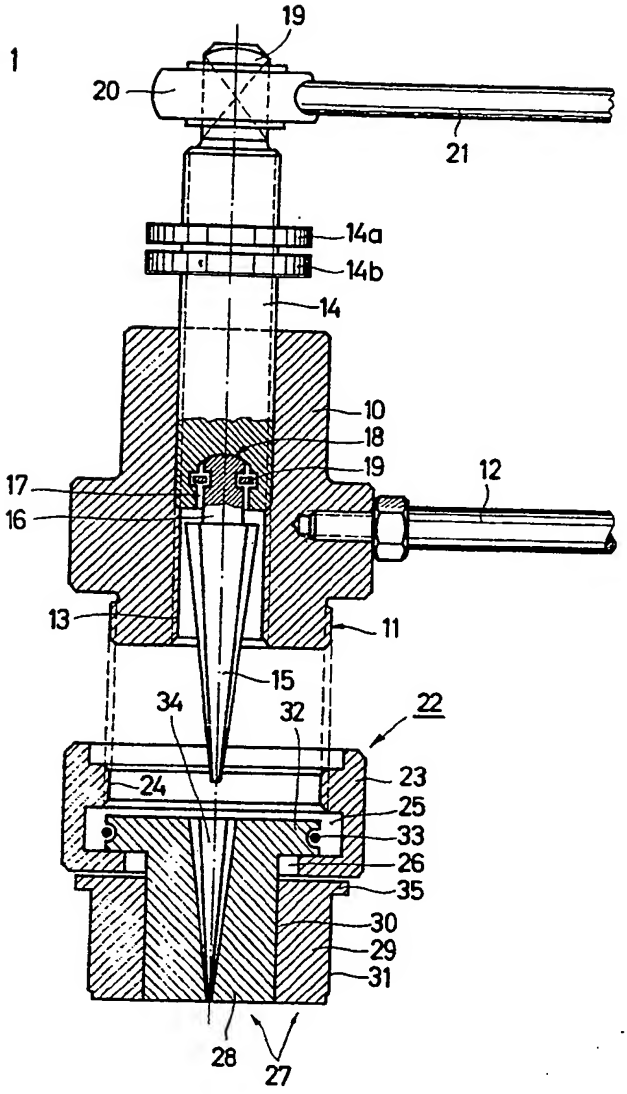
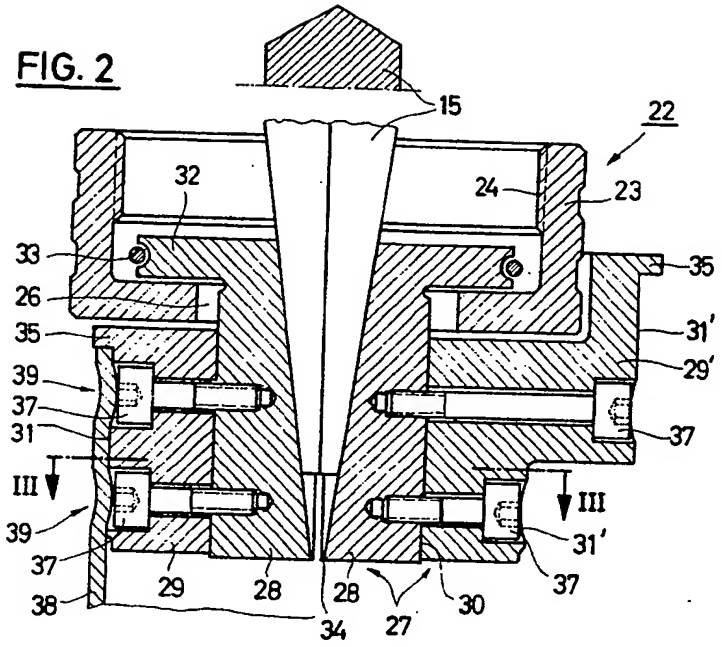


FIG. 2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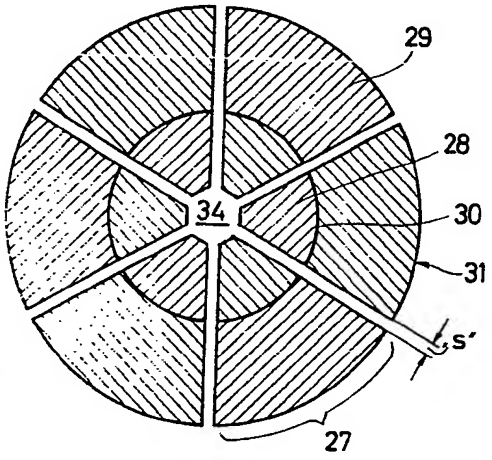
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31
s'
27

FIG. 3